PATENT ABSTRACTS OF JAPAN

(11)Publication number : 06-165036
(43)Date of publication of application : 10.06.1994

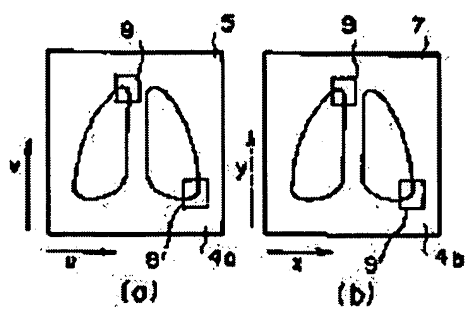
(51)Int.Cl. H04N 5/325
G06F 15/62
G06F 15/66
G06F 15/70

(21)Application number : 04-318533
(22)Date of filing : 27.11.1992

(71)Applicant : FUJI PHOTO FILM CO LTD
(72)Inventor : NAKAJIMA NOBUYOSHI
EZUKA DAIGO

(54) POSITION MATCHING METHOD FOR RADIOGRAPH

(57)Abstract:
PURPOSE: To enable speedy and accurate position matching without recording a marker or the like together with an object for position matching.
CONSTITUTION: Template areas 8 and 8' are set in an X-ray image 4a, and reference areas 9 and 9' are set in an X-ray image 4b. In this case, template matching is performed by using a correlation method so as to match the template areas 8 and 8' with the reference areas 9 and 9'. At such a time, common orthogonal coordinates are set to sheets 5 and 7. Next, the coefficient of affine transformation is calculated and concerning the template areas 8 and 8, the affine transformation of correction such as rotation/enlargement is performed. Concerning the transformed template areas 8 and 8', template matching is performed again, the coefficient of affine transformation is calculated, and the affine transformation is performed for correcting the rotation/enlargement or reduction and parallel movement.



LEGAL STATUS
[Date of request for examination] 20.02.1997

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the approach of aligning an image without using the marker for [it is still more detailed and] alignment to the inside of each radiation image about the approach of amending the location gap of two or more images which performs superposition processing or subtraction processing of a radiation image, and aligning an image.
[0002]
[Description of the Prior Art] An accumulative fluorescent substance is used in recent years. The radiation image information of the photographic subject of the body etc. once The sheet of an accumulative fluorescent substance Record for (calling it an accumulative fluorescent substance sheet hereafter), and accelerated-phosphorescence luminescence of this is scanned and carried out with excitation light. the method of reading this accelerated-phosphorescence luminescence light in photoelectricity, acquiring a picture signal, processing this picture signal and obtaining the radiation image of the good photographic subject of diagnostic fitness is proposed (for example, JP,55-12429,A --) said -- 55-116340 a number -- said -- 55-163472 a number and 56-11395 -- said -- 56-104645 Number etc. It can reproduce as hard copy or this final image can be reproduced on CRT.
[0003] On the other hand, superposition processing of a radiation image is better known than before (for example, refer to JP,56-11399,A). Generally, although a radiation image is used for the purpose of the object for a diagnosis, and others, it is required that the minute absorption-of-radiation difference of a photographic subject should be detected good in the use. extent of this detection in a radiation image -- contrast detectivity -- or although it is only called detectivity, the higher thing of this detectivity can be said to be that the diagnostic engine performance is also high and practical value is a high radiation image. Therefore, although to make this detectivity high is desired in order to raise the diagnostic engine performance, that biggest failure factor is various noises. Superposition processing is the approach of decreasing the various noises sharply, enabling observation also of few absorption-of-radiation differences of a photographic subject clearly in the last image, and raising detectivity sharply. That is, a radiation image is photoed on the accumulative fluorescent substance sheet piled up two or more sheets (are recording record), addition processing of two or more picture signals which obtained having covered [this / of two or more sheets] it over reading processing is carried out, and the various above-mentioned noises are decreased by this.
[0004] Conventionally, in order to actually perform this superposition processing, two accumulative fluorescent substance sheets are put into a cassette in piles, a photographic subject is photoed, the usual reading processing is serially performed to the accumulative fluorescent substance sheet of two sheets, 2 sets of picture signals are acquired, and the approach of carrying out addition processing of 2 sets of these picture signals is used.
[0005] Moreover, on the other hand, subtraction processing of a radiation image is better known than before. After reading in photoelectricity two radiation images photoed on different conditions from the subtraction of this radiation image and acquiring a digital picture signal, Each pixel of both images is

made to correspond and subtraction processing of these digital picture signals is carried out, it is the approach of acquiring the difference signal which makes the specific structure in a radiation image extracting, and if the difference signal which carried out in this way and was acquired is used, the radiation image with which only the specific structure was extracted is reproducible.
[0006] There are the following two approaches in this subtraction processing fundamentally. Namely, (1) From the picture signal of the radiation image as which the specific structure was emphasized by contrast-medium impregnation The so-called time amount subtraction processing in which the specific structure is extracted by subtracting the picture signal of the radiation image with which the contrast medium is not poured in (subTORAKUTO), (2) Irradiate the radiation which has the energy distribution which is different from each other to the same photographic subject, or change energy part blanket-like voice and the radiation after photographic subject transparency is irradiated at two radiation detection means. It is the so-called energy subtraction processing in which make the image with which the specific structures differ by that cause exist between two radiation images, subtract after carrying out suitable weighting between this two picture signal of a radiation image after that (subTORAKUTO), and the image of the specific structure is extracted.
[0007] Since especially this subtraction processing is a very effective approach on a medical diagnosis, it is greatly observed in recent years and that research and development are furthered briskly, making full use of the electronics technique.
[0008] However, the following problems arise in the superposition art and subtraction art of the radiation image using an accumulative fluorescent substance sheet which was mentioned above.
[0009] Namely, it sets to said each art which used the accumulative fluorescent substance sheet. Insert the accumulative fluorescent substance sheet of two sheets (there is also a case of three or more sheets) in a camera base at sequential or coincidence, and superposition or the radiation image which should be carried out subtraction is photoed. Although said radiation image is read by detecting the accelerated-phosphorescence luminescence light emitted by inserting an accumulative fluorescent substance sheet in a reader according to an individual after that, and irradiating excitation light each time at an accumulative fluorescent substance sheet In this process, though the mechanical precision of all the equipments in connection with photography and read is raised, location gap and rotation gap will arise between superposition or the image by which subtraction should be carried out. Consequently, although various noises are equalized by this processing and decrease in superposition processing Begin the part of the edge of the structure in an image, dotage arises in the whole image, and the image which should be observed stops fitting observation. The image which should be eliminated in subtraction processing is eliminable, or the image which should be extracted conversely is eliminated, a fake image arises, and it becomes impossible moreover, to obtain exact subtraction imaging. Thus, it was found out by the location gap and rotation gap which were mentioned above that serious trouble arises on a diagnosis.
[0010] Since are recording record of the radiation image is carried out into the accumulative fluorescent substance as a latent image if such gap arises between the radiation image information by which are recording record was carried out at the accumulative fluorescent substance sheet, unlike the case of the X-ray photograph film which can regard an X-ray picture as a visible image, it was not able to say that two X-ray photographs were set by viewing, but gap amendment will become very difficult.
[0011] Furthermore, if well-known data processing is performed conventionally that the data of the radiation image read though the location gap and rotation gap which are produced between two radiation images with a certain means could be detected should be amended, especially, great time amount will be spent in the case of amendment of rotation gap, and it will become a practically very big problem.
[0012] These people have proposed the subtraction art of the radiation image using a marker with a configuration which provides JP,58-163338,A with an origin/datum or a datum line. This approach records said marker on the accumulative fluorescent substance sheet of two sheets in the location fixed to the radiation image, detects said marker in the case of the read of this radiation image, and rotates and/or moves either of the radiation images which should calculate and carry out subtraction of location gap and the rotation gap on digital data, and image data subtracts between each pixel to which this radiation image corresponds. The process of the alignment in the subtraction art of the radiation image

using this marker can also be adapted also for the superposition art mentioned above. In that case, what is necessary is just to perform addition processing of image data between each pixel [/ image / radiation], after aligning.

[0013]

[Problem(s) to be Solved by the Invention] However, in this approach, are recording record of the marker which was mentioned above must be carried out with a photographic subject at an accumulative fluorescent substance sheet at every photography of a radiation image. And from the part which laps with the location of the marker of this radiation image that carried out are recording record, there is a problem that image information of a photographic subject cannot be obtained.

[0014] Then, without recording a marker etc. with a photographic subject in view of the above-mentioned situation for alignment, it is quick and this invention aims at offering the alignment approach of the radiation image which can carry out high alignment of precision.

[0015]

[Means for Solving the Problem] In the approach the alignment approach of the image of this invention aligns two or more radiation images for superposition processing of a radiation image or subtraction processing At least two areas of interest which are mostly common among these two or more images on two or more images which align are set up. A criteria field and said area of interest of other images are made into a template field for said each area of interest of the image which serves as criteria among these two or more images. Define a direct coordinate about said each of two or more images, and template matching which makes said template field match with said criteria field is performed. The formula, [0016] which change the coordinate value of an image including said template field into the coordinate value of an image including said criteria field so that the coordinate value of at least two corresponding points which corresponds mutually [said two or more images] may be calculated and these corresponding points may be in agreement

[Equation 2]

$$\begin{pmatrix} u \\ v \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} e \\ f \end{pmatrix}$$

[0017] however, the multiplier in u and v the coordinate of a criteria field, x, and y indicate the coordinate of a specific region, and a, b, c, and d indicate rotation amendment and expansion, or reduction percentage amendment to be -- e and f ask for the multiplier of the affine transformation expressed with the multiplier which shows parallel displacement amendment. The 1st affine transformation which performs rotation amendment, expansion, or reduction percentage amendment at least about two or more images which include said template field using this multiplier is performed. About two or more images which performed this 1st affine transformation, template matching is performed again. It asks for the multiplier of the affine transformation expressed by said formula, and is characterized by performing the 2nd affine transformation which performs rotation amendment, expansion or reduction percentage amendment, and parallel displacement amendment about two or more images which include said template field using this multiplier.

[0018] Moreover, in the alignment approach of the image of this invention, it is more desirable to repeat said 1st affine transformation two or more times at the point of raising the precision of alignment. In addition, since the time amount taken to complete alignment in connection with it also increases, it is desirable [this precision rises as it makes the count which performs affine transformation increase, but] to set up the count which performs affine transformation, taking that time amount into consideration, and to align desired precision.

[0019] Template matching is the processing which discovers the location which can take matching most by moving this template field on an image including this criteria field when a template field and a criteria field are set up, as mentioned above here, and the point of expressing the location gives the coordinate of corresponding points.

[0020] In such template matching, a correlation technique and SSDA (Sequential Similarity Detection Algolithms) are mentioned to the evaluation scale showing whenever [matching].

[0021] This correlation technique makes the scale of superposition the corresponding value (a standardization value is called below) which computed the product for every pixel and standardized the sum of that product. This standardization computes the sum of the own product (square) of a pixel in each field, computes the product of each sum further, and is performed by making the square root of this product into said corresponding denominator of the sum of the product for every pixel. When superposition is perfect, it is thought that all the products of a molecule do not serve as the sum of a square by a noise (noise) etc., but for this reason it turns into maximum nearest to 1 even if a standardization value is not set to 1. Therefore, a standard field is variously moved on the included image, and a template field is considered that superposition was attained with the migration from which the standardization value mentioned above becomes max. However, the migration to which this standardization value serves as max cannot be judged if all migration is not completed. the detail of this approach -- for example, Smith ** -- "Automated cloud tracking using precisely aligneddigital ATS pictures" ibid. and 1972 -- July [per year] c-21 volumes, and 715-729 It is indicated by the page.
[0022] Moreover, SSDA makes the sum (remainder) of the absolute value of a difference the scale of superposition for every pixel. When superposition is perfect, even if the remainder is not set to 0 by a noise (noise) etc., it is thought that it becomes min. Therefore, I move a template field variously on an image including a criteria field, and think that superposition was attained with the migration to which the remainder becomes min. Under the present circumstances, if superposition has shifted, when adding one by one about each pixel, the remainder will increase rapidly. Then, when exceeding the threshold which has the remainder in the middle of addition, the method of closing addition immediately and moving to the next migration is this SSDA. The count to be used is only addition, and since it is moreover in the middle of many cases and is closed, computation time is shortened sharply. the detail of this approach -- Barnea's and others "A class of algorithms for fast digital image registration" IEEE.Trans. and 1972 -- February [per year] c-21 volumes, and 179-186 It is indicated by the page.
[for example,]
[0023] After asking for the perfect field of superposition by these approaches in this invention, rotation amendment and expansion, or reduction percentage amendment is performed at least about the image which performs affine transformation expressed by the above-mentioned formula, and includes a template field. That is, affine transformation is performed using the multipliers a, b, c, and d which show rotation amendment and expansion, or reduction percentage amendment.
[0024] Subsequently, template matching again mentioned above is performed about the image which performed this affine transformation. Since this 2nd template matching is what is performed to the image with which rotation amendment and expansion, or reduction percentage amendment was performed, it turns into more exact matching as compared with template matching performed first.
[0025] Rotation amendment, expansion or reduction percentage amendment, and parallel displacement amendment are performed about the image which includes a template field by the affine transformation based on the corresponding points obtained by template matching. That is, affine transformation is performed using the multipliers e and f which show the multipliers a, b, c, and d and parallel displacement amendment which show rotation amendment and expansion, or reduction percentage amendment.
[0026]
[Function] By the alignment approach of the radiation image of this invention, without recording the marker for alignment with a photographic subject, a specific region can be instead set up into a radiation image, and the radiation image information of the part which overlapped the marker conventionally in order to perform rotation and affine transformation to which you make it expand or reduce for that field twice [at least] about this specific region can be obtained, and the precision of alignment can also be raised.
[0027]
[Example] Hereafter, this invention is explained to a detail based on the example shown in a drawing.
[0028] Drawing 1 is the schematic diagram of the X-rays equipment which is one example of the equipment which records the radiation image used for this invention. The X-ray picture obtained by this

photography is used for energy subtraction processing.
[0029] On both sides of the filter 6, the accumulative fluorescent substance sheets 5 and 7 have piled up by turning this sheet 7 down in between. Besides, X-ray tube 2 which emits X-ray 3 through a photographic subject 4 is arranged. As mentioned above, X-rays equipment 1 is constituted.
[0030] A photographic subject 4 is irradiated by X-ray 3 emitted from this X-ray tube 2. X-ray 3a which penetrated the photographic subject 4 irradiates the 1st accumulative fluorescent substance sheet 5 -- having -- a part of energy of X-ray 3a -- this -- it is recorded on the 1st accumulative fluorescent substance sheet 5, and, thereby, are recording record of the X-ray picture of a photographic subject 4 is carried out at this sheet 5. X-ray 3c which X-ray 3b which penetrated the sheet 5 penetrated the filter 6 further, and penetrated this filter 6 is irradiated by the 2nd accumulative fluorescent substance sheet 7. Thereby, are recording record of the X-ray picture of a photographic subject 4 is carried out also at this sheet 7.
[0031] Drawing 2 is drawing which expressed typically the X-ray picture by which are recording record was carried out to each accumulative fluorescent substance sheets 5 and 7. each accumulative fluorescent substance sheets 5 and 7 -- are recording record of the X line drawing each images 4a and 4b of a photographic subject 4 is carried out mostly on the whole surface.
[0032] Drawing 3 is the perspective view of the image-processing display which is one example of the arithmetic unit which enforces the alignment approach of of the X-ray picture reader and this invention which are one example of the reading unit which reads the radiation image used for this invention, and performs subtraction processing.
[0033] After photography is performed by X-rays equipment 1 shown in drawing 1 , the 1st and 2nd one accumulative fluorescent substance sheets 5 and 7 are set at a time to the predetermined location of the X-ray picture reader 10. Here, the case of the read of the 1st X-ray picture by which are recording record was carried out is explained to the 1st accumulative fluorescent substance sheet 5.
[0034] The accumulative fluorescent substance sheet 5 which was set to the predetermined location and with which are recording record of the 1st X-ray picture was carried out is conveyed in the direction of arrow-head Y by the sheet conveyance means 15, such as an endless belt driven by the driving means which is not illustrated, (vertical scanning). the mirror 21 after a reflective deviation being carried out by the rotating polygon 19 which drives the light beam 17 emitted from the laser light source 16 by the motor 18, and carries out high-speed rotation at an arrow-head Z direction and, penetrating the focusing lenses 20, such as ftheta lens, by it on the other hand -- an optical path -- changing -- the accumulative fluorescent substance sheet 5 -- incidence -- carrying out -- the direction of vertical scanning (the direction of arrow-head Y), and abbreviation -- horizontal scanning is carried out in the perpendicular direction of arrow-head X. The light beam 17 of the accumulative fluorescent substance sheet 5 was irradiated, or the accelerated-phosphorescence luminescence light 22 of the quantity of light according to the X-ray picture information by which are recording record is carried out is emitted from a place, and this accelerated-phosphorescence luminescence light 22 is drawn with lightguide 23, and is detected by the photomultiplier (photomultiplier tube) 24 in photoelectricity. Lightguide 23 is incidence end-face 23a which fabricates light guide nature ingredients, such as an acrylic board, is made, and makes the shape of a straight line. Injection end-face 23b which was allotted so that the horizontal-scanning line on the accumulative fluorescent substance sheet 5 might be met and it might extend, and was formed in the shape of a circular ring The light-receiving side of a photomultiplier 24 is combined. incidence end-face 23a from -- the accelerated-phosphorescence luminescence light 22 which carried out incidence into lightguide 23 -- the interior of this lightguide 23 -- total reflection -- repeating -- progressing -- injection end-face 23b from -- it injects, light is received by the photomultiplier 24 and the accelerated-phosphorescence luminescence light 22 showing a radiation image is changed into an electrical signal by the photomultiplier 24. analog signal S outputted from the photomultiplier 24 -- logarithmic amplifier 25 -- a logarithm -- after being amplified-like, it is inputted into A/D converter 26, it is sampled, and the digital picture signal SO is acquired. This picture signal SO expresses the 1st X-ray picture by which are recording record was carried out to the 1st accumulative fluorescent substance sheet 5, and it is the 1st picture signal SO 1. It calls. This 1st picture signal SO 1 It is once recorded on the internal memory in

the image-processing display 30.
[0035] It has CRT display 32 which displays the visible image based on the auxiliary information and the picture signal for the keyboard 31 and directions whose image-processing indicating equipment 30 of this inputs various directions, the floppy disk driving gear 33 which it is loaded with the floppy disk as a secondary memory medium, and it drives, and the body section 34 in which CPU and the internal memory were built.
[0036] Next, 2nd picture signal SO 2 which expresses like the above the 2nd X-ray picture by which are recording record was carried out to the 2nd accumulative fluorescent substance sheet 7 It is obtained and is this 2nd picture signal SO 2. The internal memory in the image-processing display 30 once memorizes.
[0037] Thus, two picture signals [SO / SO and / 2] 1 which should perform a subtraction operation When an internal memory memorizes, they are these two picture signals [SO / SO and / 2] 1. It is read and they are these two picture signals [SO / SO and / 2] 1. Alignment of an image is performed so that the subtraction operation which corresponded between each pixel of X line drawing each images to support may be performed.
[0038] The alignment approach of two X-ray pictures which the picture signal SO 1 and SO2 , in this example express here is explained.
[0039] In the alignment approach of the radiation image of this invention, it is important to set up at least two or more areas of interest (complicated part of structure like a cross edge) characteristic in X line drawing each images 4a shown in drawing 2 and 4b. Then, the area of interest is set as the template field 8 and 8', and the area of interest is set as this X-ray picture 4a as the criteria field 9 and 9' at this X-ray picture 4b. Here, actuation of doubling the template field 8 and 8' with the criteria field 9 and 9', respectively shall be performed. As a direct coordinate which can come, simultaneously is common, the system of coordinates of a x axis and the y-axis are set to said sheet 7, and the system of coordinates of u shaft and v shaft are set to said sheet 5. This x axis and u shaft are the longitudinal directions of the space of drawing 1 , and the y-axis and v shaft are directions perpendicular to the space of drawing 1 .
[0040] Here, template matching which makes said template field match with said criteria field as mentioned above using a correlation technique or SSDA is performed. The point that a standardization value serves as max as mentioned above in the correlation technique gives the coordinate of the corresponding points (sampling point) indicated below. Or the point that the sum of the remainder serves as min as mentioned above also in SSDA gives the coordinate of corresponding points.
[0041] 1st picture signal SO 1 It is the (X1, Y1), and 2nd picture signal SO 2 about the coordinate of each sampling point of the template field on the 1st X-ray picture to support. When the coordinate of each sampling point of the criteria field on the 2nd X-ray picture to support is set to (X2 and Y2) and a, b, c, d, e, and f are made into a multiplier, it is affine transformation [0042].
[Equation 3]

$$\begin{pmatrix} X_2 \\ Y_2 \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \cdot \begin{pmatrix} X_1 \\ Y_1 \end{pmatrix} + \begin{pmatrix} e \\ f \end{pmatrix} \quad \cdots\cdots (1)$$

[0043] By it being alike, and following and changing the coordinate of the 1st X-ray picture, the 1st X-ray picture and 2nd X-ray picture are piled up. here -- (1) expanding or reducing the 1st whole X-ray picture mutually-independent in the direction of X, and the direction of Y in the coordinate transformation based on a formula -- this -- all of rotating the 1st whole X-ray picture and carrying-out-in direction of X and direction of Y-parallel displacement of this 1st X-ray picture **s are performed to coincidence. However, in the alignment approach of the radiation image of this invention, since the alignment is not necessarily performed only by one affine transformation, by the 1st affine transformation, rotation and expansion, or conversion of reduction percentage shall be performed. That is, what is necessary is just to perform a comparatively easy parallel displacement by the 2nd or the last affine transformation, since rotation and expansion, or contraction is again performed even if it performs a parallel displacement here.
[0044] Next, (1) How to ask for the multipliers a, b, c, d, e, and f contained in a formula is explained.

[0045] (1) A formula is [0046].
[Equation 4]
$$X_2 = aX_1 + bY_1 + e \quad \cdots\cdots (2)$$

[0047]
[Equation 5]
$$Y_2 = cX_1 + dY_1 + f \quad \cdots\cdots (3)$$

[0048] It is alike and is divided. They are the marks 11a, 12a, and 13a on the 1st X-ray picture here. Each coordinate is carried out to (X12, Y12), and (X13, Y13), respectively (X11, Y11), and it is a mark on the 2nd X-ray picture. Each coordinate of 11a', 12a', and 13a' is carried out to (X22, Y22), and (X23, Y23), respectively (X21, Y21). At this time, it is (2). A formula and (3) From a formula, it is [0049].
[Equation 6]
$$X_{21} = aX_{11} + bY_{11} + e \quad \cdots\cdots (2a)$$

[0050]
[Equation 7]
$$X_{22} = aX_{12} + bY_{12} + e \quad \cdots\cdots (2b)$$

[0051]
[Equation 8]
$$X_{23} = aX_{13} + bY_{13} + e \quad \cdots\cdots (2c)$$

[0052]
[Equation 9]
$$Y_{21} = cX_{11} + dY_{11} + f \quad \cdots\cdots (3a)$$

[0053]
[Equation 10]
$$Y_{22} = cX_{12} + dY_{12} + f \quad \cdots\cdots (3b)$$

[0054]
[Equation 11]
$$Y_{23} = cX_{13} + dY_{13} + f \quad \cdots\cdots (3c)$$

[0055] It becomes. Since it is six, a, b, c, d, e, and f, it can ask based on six formulas of the above (2a), (2b),; (2c) (3a), (3b), and (3c), and the multiplier for which it should ask here is [0056].
[Equation 12]
$$a = \frac{\{(X_{21}-X_{22})(Y_{11}-Y_{13}) - (X_{21}-X_{23})(Y_{11}-Y_{12})\}}{\{(X_{11}-X_{12})(Y_{11}-Y_{13}) - (X_{11}-X_{13})(Y_{11}-Y_{12})\}} \quad \cdots\cdots (4)$$

[0057]
[Equation 13]
$$b = \frac{\{(X_{21}-X_{22})(X_{11}-X_{13}) - (X_{21}-X_{23})(X_{11}-X_{12})\}}{\{(Y_{11}-Y_{12})(X_{11}-X_{13}) - (Y_{11}-Y_{13})(X_{11}-X_{12})\}} \quad \cdots\cdots (5)$$

[0058]
[Equation 14]
$$c = \frac{\{(Y_{21}-Y_{22})(Y_{11}-Y_{13}) - (Y_{21}-Y_{23})(Y_{11}-Y_{12})\}}{\{(X_{11}-X_{12})(Y_{11}-Y_{13}) - (X_{11}-X_{13})(Y_{11}-Y_{12})\}} \quad \cdots\cdots (6)$$

[0059]
[Equation 15]

$$d = \frac{\{(Y_{21}-Y_{22})(X_{11}-X_{13})-(Y_{21}-Y_{23})(X_{11}-X_{12})\}}{\{(Y_{11}-Y_{12})(X_{11}-X_{13})-(Y_{11}-Y_{13})(X_{11}-X_{12})\}} \quad \cdots\cdots(7)$$

[0060]
[Equation 16]

$$\begin{aligned} e = \{ & (X_{21}X_{12}-X_{11}X_{22})(Y_{12}X_{13}-Y_{13}X_{12}) \\ & -(X_{22}X_{13}-X_{23}X_{12})(Y_{11}X_{12}-Y_{12}X_{11})\} \\ / \{ & (X_{12}-X_{11})(Y_{12}X_{13}-Y_{13}X_{12}) \\ & -(X_{13}-X_{12})(Y_{11}X_{12}-Y_{12}X_{11})\} \quad \cdots\cdots(8) \end{aligned}$$

[0061]
[Equation 17]

$$\begin{aligned} f = \{ & (Y_{21}X_{12}-X_{11}Y_{22})(Y_{12}X_{13}-Y_{13}X_{12}) \\ & -(Y_{22}X_{13}-X_{23}X_{12})(Y_{11}X_{12}-Y_{12}X_{11})\} \\ / \{ & (X_{12}-X_{11})(Y_{12}X_{13}-Y_{13}X_{12}) \\ & -(X_{13}-X_{12})(Y_{11}X_{12}-Y_{12}X_{11})\} \quad \cdots\cdots(9) \end{aligned}$$

[0062] It becomes.
[0063] However, since what is necessary was just to have performed rotation and expansion, or conversion of only contraction in the first affine transformation as mentioned above, it did not need to ask for e and f here, but by final affine transformation, since it was needed, how to ask for e and f was indicated here.
[0064] Thus, (4) - (7) The multipliers a, b, c, and d called for according to the formula are used, and it is (1). By performing coordinate transformation according to a formula, the inclination of the 1st X-ray picture can be made almost equal to the 2nd X-ray picture.
[0065] In the alignment approach of this invention, in order to raise that precision further, 1 time or multiple-times affine transformation is further already performed after this 1st affine transformation. The affine transformation of the 2nd henceforth performs template matching to the template field 8 in the 1st X-ray picture which performed the 1st affine transformation, and 8' again, and is (1). It asks for each multiplier of the affine transformation shown in a formula. It is (4) when finishing affine transformation as 2 times. - (9) It is (4) like [although six of multipliers a, b, c, d, e, and f are calculated by the formula] the affine transformation first performed when affine transformation was performed further. - (7) What is necessary is just to ask for multipliers a, b, c, and d according to a formula. In this case, it is (4) when performing the last affine transformation. - (9) What is necessary is just to calculate six of multipliers a, b, c, d, e, and f by the formula.
[0066] In addition, in the 1st affine transformation of the above-mentioned example, although rotation and expansion, or conversion of only reduction percentage is performed, in this conversion, a parallel displacement may be performed to coincidence.
[0067] Here, the principle whose alignment accuracy improves is explained using drawing 4 and drawing 5 by repeating affine transformation two or more times.
[0068] Drawing 4 is the graph which showed relation with the error of the relative inclination between two or more images, the location of the corresponding points obtained by template matching, and the location of true corresponding points. The more this graph makes the inclination of an image small, the more it shows that location gap of these corresponding points also decreases. Moreover, when the relative inclination of an image is 2 degrees, it is shown, for example that the error of the corresponding points obtained by template matching which was mentioned above, and true corresponding points is about 1 pixel. Although it is the inside and outside of **3 degree since the gap between actual images is

produced inside a cassette, photography equipment, and a reader, it is checked that the relation shown in drawing 4 continues and is effective in the range of about **5 degrees.
[0069] For drawing 5 , corresponding points are 100 to the direction of X, and the direction of Y. It is drawing having shown the location of the true corresponding points in the case of being in the distant location, and the corresponding points obtained by template matching a pixel every. This drawing 5 (a) shows true corresponding points, and the corresponding points from which drawing 5 (b) was obtained are shown. The corresponding points shown in this drawing 5 (b) show signs that the location gap only of the 1 pixel was carried out from corresponding points true by the case where the relative inclination of an image is 2 degrees as mentioned above.
[0070] Here, in drawing 5 (a), the slope of a line which connects true corresponding points is thetar=tan-1(100/100) =45 degree. On the other hand, in drawing 5 (b), the slope of a line which connects the corresponding points presumed by template matching becomes thetam=tan-1(101/99) =45.6 degree, when the worst, and it is shown that the gap with the slope of a line to which this connects true corresponding points is 0.6 ** at the maximum. That is, it is shown that that whose relative inclination of an image was 2 degrees has been improved by 0.6 ** by one affine transformation from the first. Subsequently, when template matching is again performed by the approach of this invention and the 2nd affine transformation is performed further, it is a gap of corresponding points by drawing 4 0.3 It turns out that it is stored within a pixel. The slope of a line which connects the corresponding points presumed by template matching at this time becomes thetam'=tan-1(100.3/99.7) =45.2 degree, when the worst, and it is shown that the gap with the slope of a line to which this connects true corresponding points is 0.2 ** at the maximum. That is, it is shown that 0.2 ** has improved by two affine transformation. Therefore, by repeating affine transformation two or more times, as mentioned above, the relative gap about a rotation of an image is made to decrease gradually, namely, it will be understood that the precision of alignment improves gradually.
[0071] Here, corresponding points are 100 to the direction of X, and the direction of Y. A pixel every, although the example in the case of being in the distant location was shown, this invention is not limited to this. It is in the location which 1000 pixels of corresponding points left at a time in the direction of X, and the direction of Y as another example, and the case where the relative inclination of an image is 2 degrees is explained. The inclination of ****** which connects true corresponding points is 45 degrees similarly. The slope of a line which, on the other hand, connects the corresponding points presumed by template matching becomes thetam=tan-1(1001/999) =45.06 **, when the worst, and it is shown that the gap with the slope of a line to which this connects true corresponding points is 0.06 degrees at the maximum. That is, that whose relative inclination of an image was 2 degrees shows that 0.06 degrees has improved by one affine transformation. This shows that the precision of alignment improves, so that the distance between corresponding points is large.
[0072]
[Effect of the Invention] Without recording a marker etc. with a photographic subject for alignment, since according to the alignment approach of the radiation image of this invention an area of interest is set as two or more images of each which should be aligned and it was made to perform affine transformation twice [at least] about those areas of interest, it is quick and high alignment of precision can be carried out.

[Translation done.]